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(54) **SEAL INTEGRITY FOR MAILPIECE ENVELOPES**

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(52) **U.S. Cl.** ..... **53/460**; 53/469; 53/569

(58) **Field of Classification Search** ..... 53/460,  
53/469, 569

See application file for complete search history.

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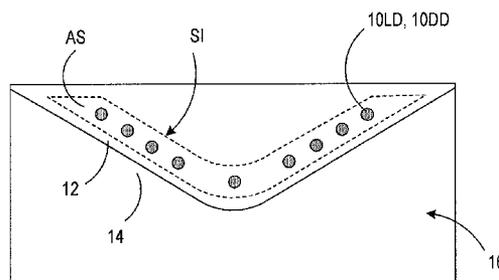
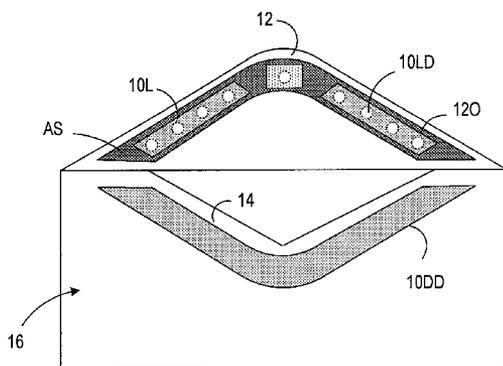
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(57) **ABSTRACT**

A method, system and article for producing an envelope having improved seal integrity. A method includes the steps of: disposing at least one material at the interface of the adhesive seal between the flap and the body portion of the envelope, which material radiates thermal energy when combined with an activating agent. The envelope is then sealed by closing the flap onto the body portion of the envelope and combining the material with the activating agent at the sealing interface so as to change the thermal energy radiated therefrom. The seal is then inspected to determine whether the thermal energy radiated from the activated material has changed thereby confirming that a seal has been produced between the flap and body portion of the envelope. The system and article are directed to the various modules of a mailpiece fabrication system employed to produce the mailpiece including an inspection module for confirming that a seal has been formed.

**13 Claims, 5 Drawing Sheets**



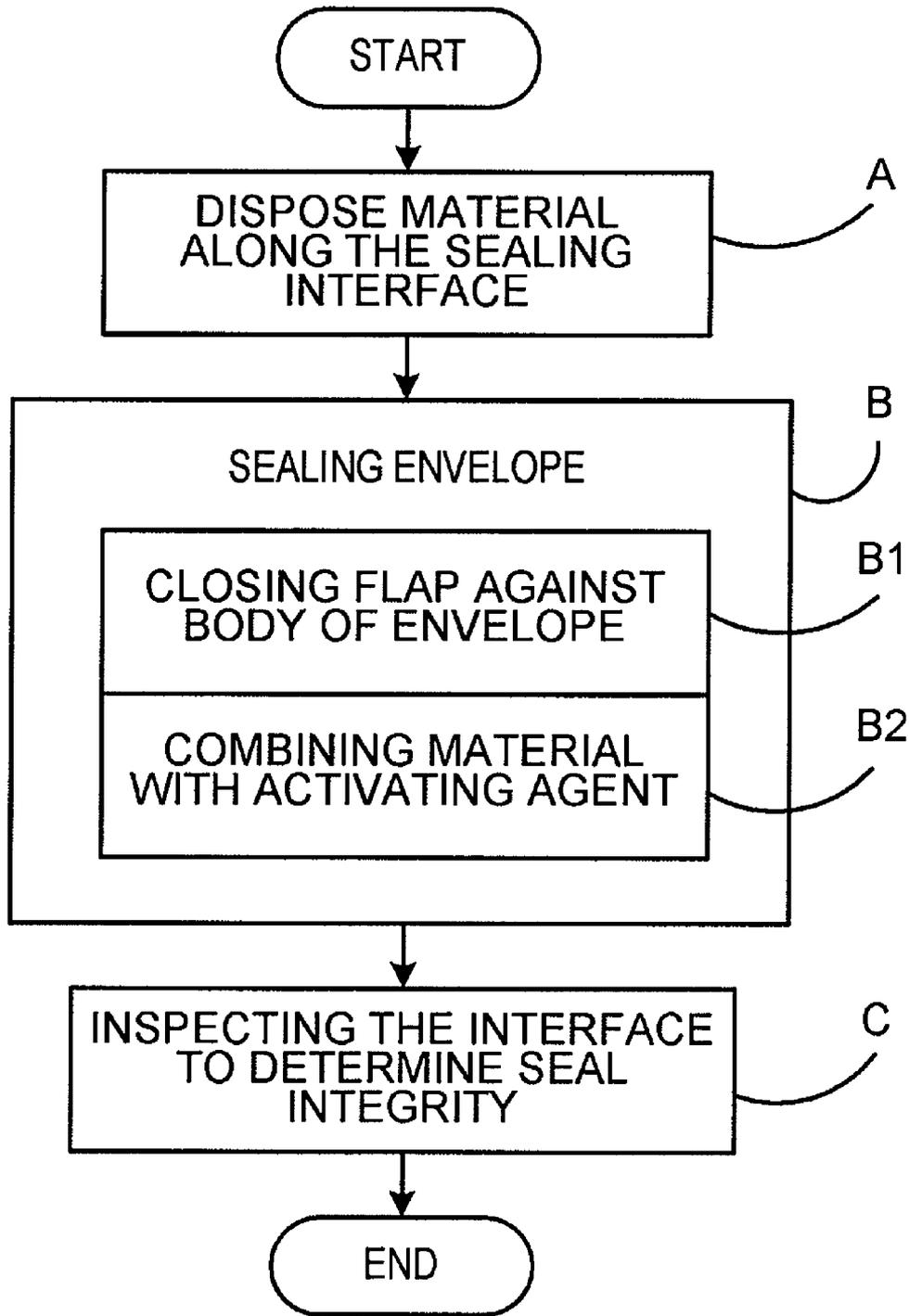


FIG. 1

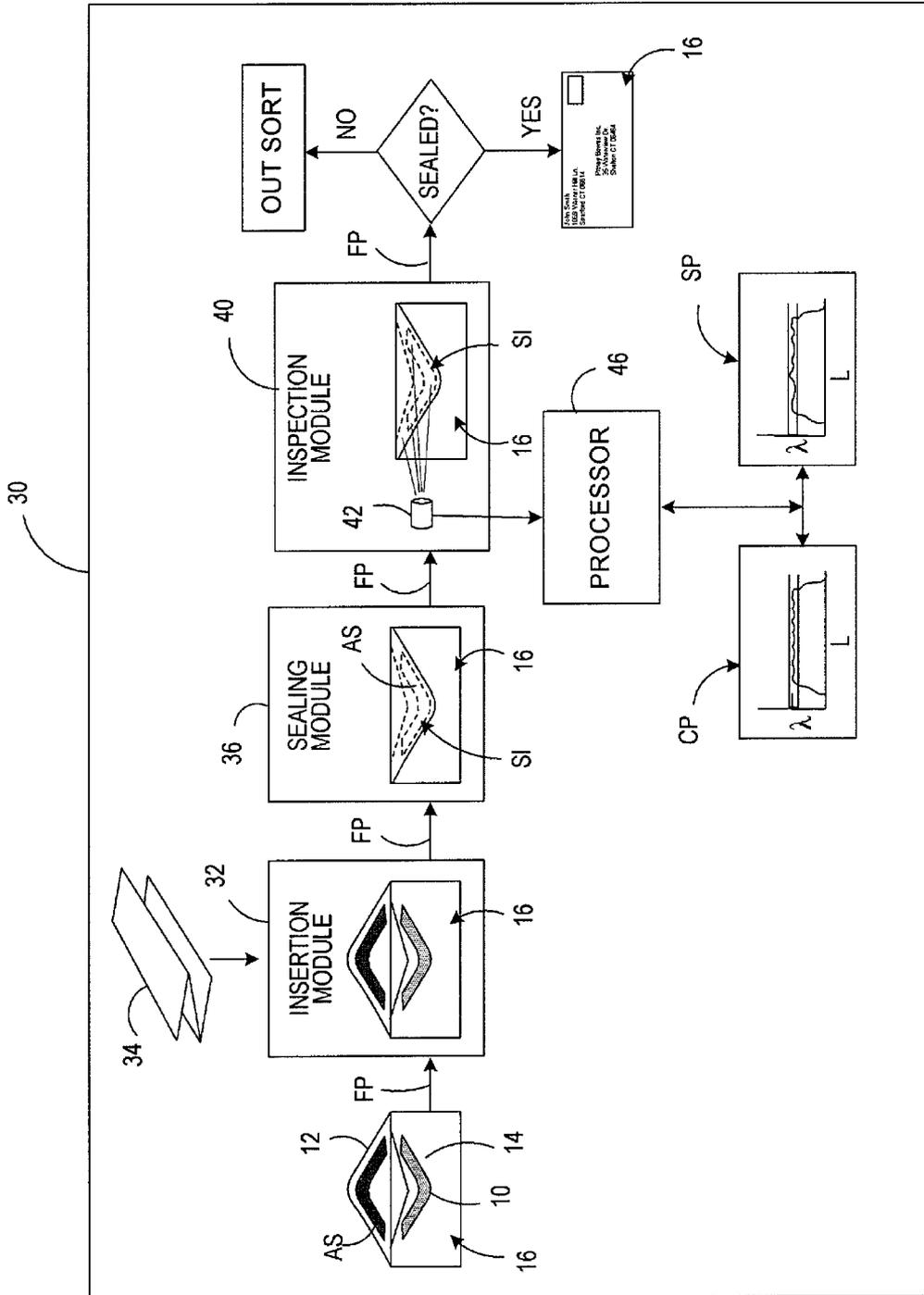


FIG. 2

FIG. 3A

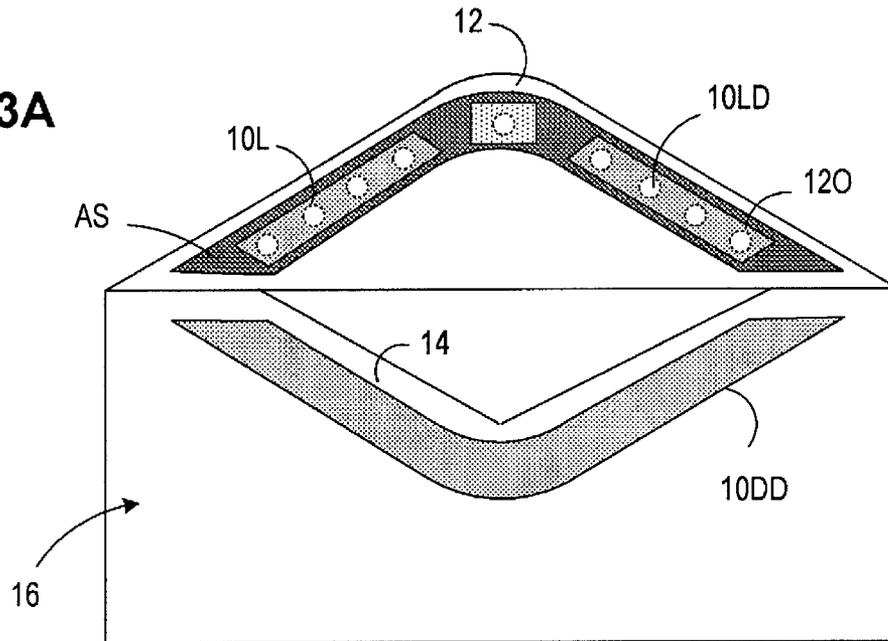


FIG. 3B

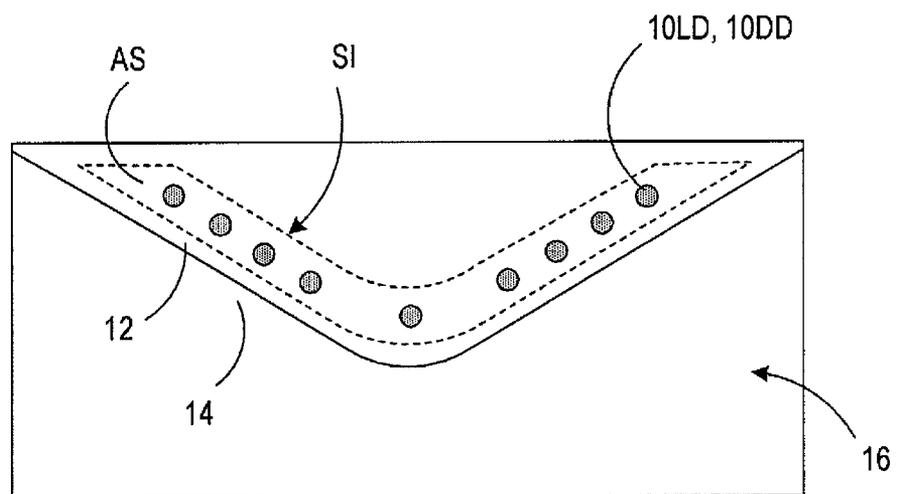


FIG. 4A

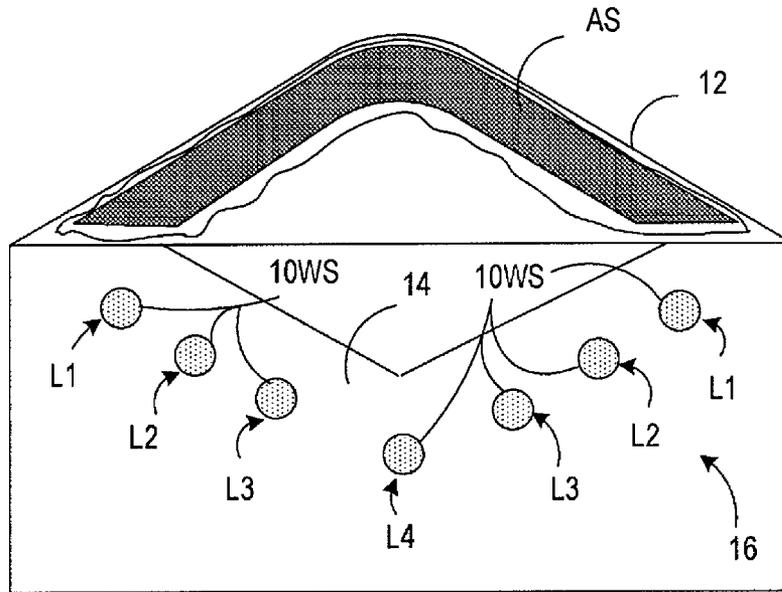


FIG. 4B

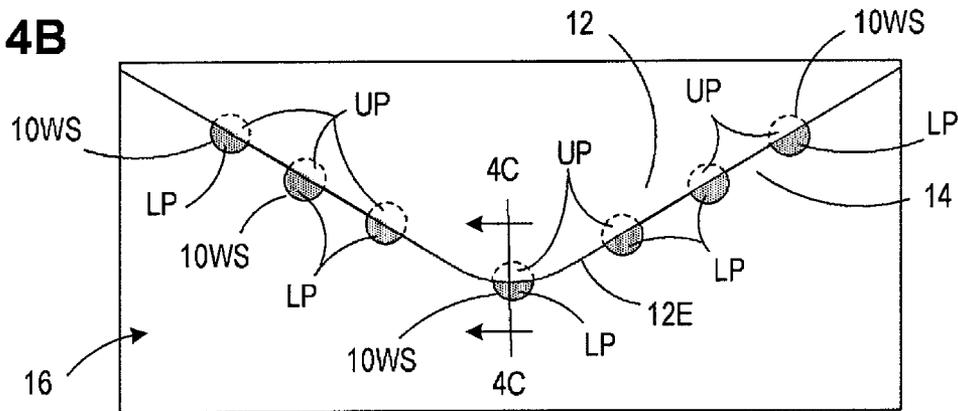


FIG. 4C

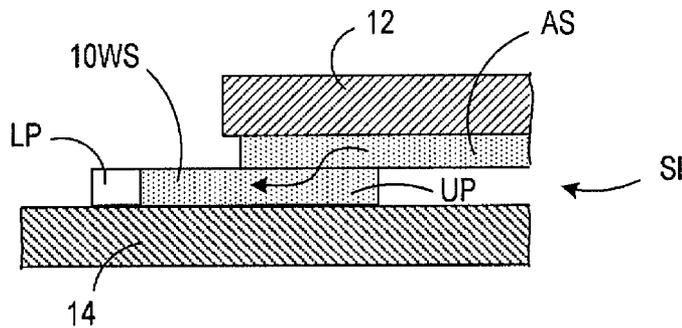


FIG. 5A

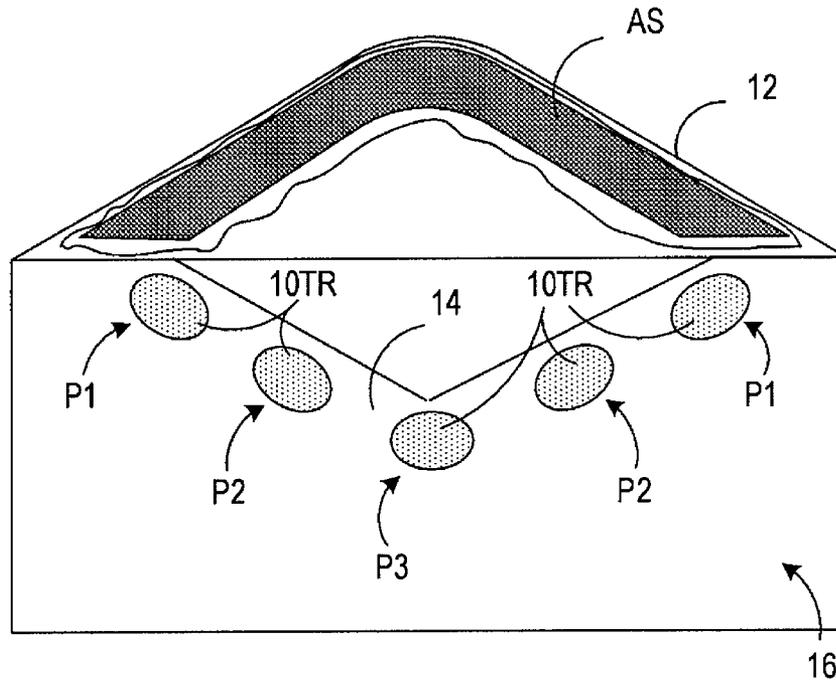
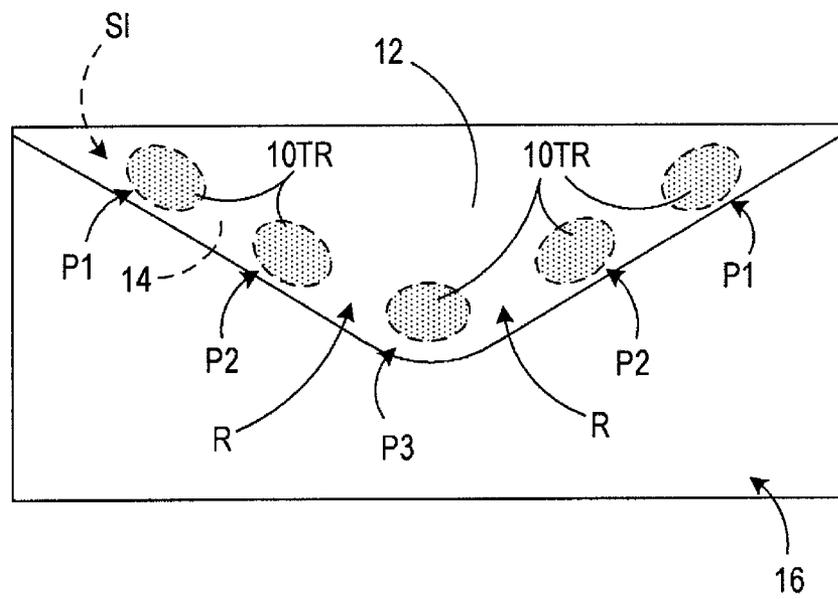


FIG. 5B



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## SEAL INTEGRITY FOR MAILPIECE ENVELOPES

### TECHNICAL FIELD

The present invention relates to a method for sealing mailpieces and, more particularly, to a new and useful method, system and article for producing a mailpiece envelope having improved seal integrity.

### BACKGROUND OF THE INVENTION

Mailing creation systems such as, for example, a mailing machine or mailpiece inserter, often include various modules dedicated to automating a particular task in the fabrication of a mailpiece. For example, in a mailpiece inserter, an envelope is conveyed downstream utilizing a transport mechanism, such as rollers or a belt, to each of the modules. Such modules include, inter alia, (i) a singulating module for separating a stack of envelopes such that the envelopes are conveyed, one at a time, along the transport path, (ii) a folding module for folding mailpiece content material for subsequent insertion into the envelope, (iii) a chassis or insertion module where an envelope is opened and the folded content material is inserted into the envelope, (iv) a moistening/sealing module for wetting the flap sealant and closing the flap to the body of the envelope, (v) a weighing module for determining the weight for postage, and (vi) a metering module for printing the postage indicia based upon the weight and/or size of the envelope, i.e., applying evidence of postage to the mail piece. While these of some of the more commonly assembled modules, i.e., for both mailing machines and mailpiece inserters, it will be appreciated that the particular arrangement and/or need for specialty modules, will be dependent upon the needs of the user/customer.

Recently, the need for privacy has become increasingly important due to changes in the laws related to the disclosure of health-related medical information/medical records i.e., the Health Insurance Portability and Accountability Act (HIPAA) and the increased frequency of identity theft/fraud. As a result, those business entities responsible for mailing such information, e.g., health care providers, insurance companies and financial institutions, are seeking assurances that the mail produced by such automated equipment are properly sealed and, to the extent practicable, tamper resistance, e.g., a perpetrator cannot open and reseal an envelope without some evidence of the potentially fraudulent activity. Various methods and systems are employed for sealing envelopes, however, none currently exhibit the degree of seal integrity sought by those responsible for mailing such records/information.

Conventionally, sealing modules include a device for moistening the glue line on the flap of envelopes in preparation for sealing to the body of the envelopes. The moistening device typically includes an applicator such as a brush, foam or felt. A portion of the applicator may be disposed in a fluid reservoir to wick moistening fluid to the flap sealant. The moistening fluid is typically water, or water with a biocide to prevent bacteria from developing in the fluid reservoir of the module.

While these moistening devices and applicators are acceptable for most mail applications, there is no method or system to ensure that (i) the proper amount of moistening fluid has been applied (ii) the flap sealant has been wetted along the full length/width of the glue line or (iii) the flap and body have come into contact so as to produce a proper seal. Consequently, there is no assurance that the mailpiece has been sealed, i.e., there is no seal integrity.

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Consequently, a need exists for a method, system and article which produces an envelope having improved seal integrity.

### SUMMARY OF THE INVENTION

A method, system and article is provided for producing an envelope having improved seal integrity. A method includes the steps of: disposing at least one material at the interface of the adhesive seal between the flap and the body portion of the envelope, which material radiates thermal energy when combined with an activating agent. The envelope is then sealed by closing the flap onto the body portion of the envelope and combining the material with the activating agent at the sealing interface so as to change the thermal energy radiated therefrom. The seal is then inspected to determine whether the thermal energy radiated from the activated material has changed thereby confirming that a seal has been produced between the flap and body portion of the envelope. The system and article are directed to the various modules of a mailpiece fabrication system employed to produce the mailpiece including an inspection module for confirming that a seal has been formed.

### BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate presently various embodiments of the invention, and assist in explaining the principles of the invention.

FIG. 1 depicts a block diagram of the method steps employed for producing a mailpiece having improved seal integrity according to the present invention.

FIG. 2 is a schematic illustration of a mailpiece fabrication system incorporating the teachings of the present invention wherein a sealing module causes an activating agent to react with a material disposed along the sealing interface of an envelope and wherein a detection/inspection module examines the sealing interface for a change in color produced by the material.

FIG. 3a depicts one embodiment of the present invention wherein the method includes the steps of disposing a leuco dye material on one side of the sealing interface, i.e., along the flap of the envelope and a dye developer on the other side of the sealing interface, i.e., along the body portion of the envelope so as to produce a change in color when combined in the presence of a moistening fluid.

FIG. 3b depicts the envelope of FIG. 3a in a sealed condition and a translucent window for viewing changes in color when the leuco dye and dye developer react.

FIG. 4a depicts another embodiment of the present invention wherein the method includes the steps of depositing a color sensitive material along the body portion of the envelope, the color sensitive material changing color in the presence of an aqueous liquid, and wetting the color sensitive material by moistening the flap of the envelope and closing the flap against body of the envelope.

FIG. 4b depicts the envelope of FIG. 4a in a sealed condition wherein the moistening fluid wicks into the color sensitive material which extends below the edge of the flap (i.e., in its sealed position against the body) for examination by the detection/inspection module.

FIG. 4c depicts a cross-sectional view taken substantially along line 4c-4c of FIG. 4b for illustrating the wicking action of the color sensitive material to facilitate examination of the detection/inspection module.

FIG. 5a depicts another embodiment of the present invention wherein the method includes the step of depositing a

thermally reactive material along the body portion of the envelope such that thermal energy is radiated when the thermally reactive material combines with an activating agent e.g., such as by moistening and closing the flap against body of the envelope.

FIG. 5b depicts the envelope of FIG. 5a in a sealed condition wherein the activating agent causes the thermally reactive material to release/absorb energy which can be sensed by a detection device.

#### DETAILED DESCRIPTION OF AN EMBODIMENT OF THE INVENTION

The method, system and article for producing an envelop having improved seal integrity will be described in the context of a mailpiece insertion system. Although, it should be appreciated that the description is merely illustrative of a typical embodiment and that the invention is applicable to any mailpiece creation system. In one embodiment of the invention, seal integrity is confirmed by examining optical/visual changes which occur when one or more materials are chemically combined or activated. More specifically, a strip, or a predetermined pattern, of at least one material is disposed on at least one of the flap and body portion of an envelope and chemically combined/activated by another material/agent to produce a measurable result/reaction.

Relying on this method, i.e., as evidence that a seal has been formed, requires that an assumption be made concerning the combination/activation of the strip/pattern of material disposed in/proximal to the adhesive sealant. That is, it is assumed that a seal is formed when a material is activated, or combined with another material, to generate predictable, measurable and/or visible results. As a result of the flow of material, or changes in state by activating/combining the material with another material (e.g., a developer/activating agent), an assumption can be made concerning the integrity of the seal. That is, if the material has mixed with another material, or been activated so as to transition to another form/state, then the adhesive, in/around the activated material/combined materials, has also been adequately combined to develop a seal. Hence, the material along the sealing interface can be viewed as providing evidence that another operation/process, i.e., sealing, has occurred.

In another embodiment, seal integrity is confirmed by examining the thermal effects due to the reaction of the material with the activating agent. Inasmuch as all chemical reactions are either exothermic (i.e., heat releasing) or endothermic (i.e., heat absorbing), the heat energy released/absorbed may be detected by an InfraRed (IR) sensor. In one embodiment of the method, a material, which releases heat in the presence of an aqueous solution, is disposed on the body portion of the envelope. The sealing strip along the flap of the envelope is moistened by the sealing module and closed against the body portion such that an exothermic reaction occurs when the moistening liquid contacts the material. An IR sensor, disposed downstream of the sealing module, senses the release of thermal energy and compares the difference to other portions of the same envelope, or to a standard acceptance pattern/thermal image of the envelope. Should the difference in temperature exceed a threshold value, it can be assumed that the sealing interface has been moistened along the length of the sealing strip (or, minimally at critical locations along the length) and that the efficacy of the adhesive seal is within acceptable margins.

In yet another embodiment, seal integrity is confirmed by examining traces of a conductive wire or material disposed in or around the sealant strips. Once again, the sealant strips are

disposed along the sealing interface e.g., on one or both of the flap and body portion of an envelope. This method also relies on a similar assumption that when the wires are coupled, or combined, to produce an output signal, the neighboring sealant material must form a positive seal to sustain a constant/uniform output signal. Hence, the conductive traces provide evidence that a seal has occurred.

In the broadest sense of the invention and referring to FIGS. 1 and 2, step A of the inventive method incorporates at least one material 10 at the interface IF of the adhesive seal, i.e., between the flap 12 and the body portion 14 of an envelope 16, which exhibits a characteristic property when combined with an activating agent. In the context used herein, the phrase "combined with an activating agent" means any method/mechanism for activating the material such that the characteristic property is exhibited. "Activating agent" means any agent, developer, or catalyst which combines with the material to effect a chemical or physical reaction/transformation. Examples include: (i) wetting/moistening the material to change the state of the material, (ii) introducing oxygen into the material to effect an exothermic or endothermic reaction, or (iii) adding a catalyst to the material to expedite a chemical reaction. A "characteristic property" of the material means any physical attribute of the material which can be sensed by a detection apparatus such as a color scanning device, spectrometer, thermometer, IR sensor, radiation detectors, magnetometers.

The envelope 16 is sealed by closing the flap 12 onto the body portion 14 of the envelope 16 in a Step B1, and admixed, combined, or exposed to, the activating agent at the sealing interface SI in a Step B2. In a step C, the interface SI is visually inspected to determine whether the material 10 exhibits the characteristic property, i.e., providing evidence that a seal has been formed between the flap 12 and body portion 14 of the envelope 16. The sealing interface SI may be inspected or examined to determine whether the characteristic property is uniformly exhibited along the entire sealing interface SI or at discrete locations therealong. Such examination may be performed by sensing the characteristic property and comparing the same to a known or standard acceptance pattern, i.e., stored in a database of a memory storage device. These features will be understood when describing the invention in the context of a mailpiece creation system (discussed in subsequent paragraphs).

In the described embodiment, the material 10 may or may not have adhesive properties but exhibit a unique characteristic property, e.g., a property which may be visually determined or confirmed, when combined or admixed with the activating agent. The material 10 may be (i) extend the full length of the mailpiece envelope 16, i.e., following the edge contour of the flap 12 and body portion 14 of the envelope 16, (ii) be placed at various locations, e.g., at points along the flap 12 and body portion 14 to confirm the seal integrity at discrete locations, or (iii) be arranged in some combination of (i) and (ii) above to provide the necessary information concerning seal integrity. As mentioned above, may or may not have adhesive properties and may function as a tracer to provide evidence that a seal has been formed. The activating agent may be a liquid, or a solid which is caused to flow like a liquid by a moistening liquid such as an EZ-seal® moistening fluid (EZ-seal is a registered trademark of Pitney Bowes Inc. located in Stamford, Conn.).

Steps A through D above may be performed by a mailpiece creation system 30, schematically depicted in FIG. 2. More specifically, the mailpiece envelope 16 is fed along a feed path FP to various modules including an insertion/chassis module 32 where content material 34 is inserted into the pocket of the

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envelope 16. A folding module (not shown) may have folded the content material 34 before insertion into the envelope 16. Thereafter, the filled envelope 16 is conveyed to a sealing module 36 where various operations to deliver or apply an activating agent to the material along one of the flap 12 and body portions 14 of the envelope.

The material 10 may be pre-applied in a solid form along one side of the sealing interface SI, i.e., along the side of the flap 12 or the side of the body portion 14 of the envelope 16. Thereafter, the sealing module 36 employs one or more applicators or spray nozzles to apply a moistening liquid/activating agent to the opposing side of the sealing interface SI. As such, when the sealing module 36 closes the flap 12 onto the body portion 14, the moistening liquid/activating agent contacts, combines and activates the material 10. Alternatively, the material 10 and moistening liquid/activating agent may be applied along the sealing interface SI in a liquid state by the sealing module 36. That is, the material 10 may be applied to the body portion 14 of the envelope 16 while the moistening fluid/activating agent is applied to the flap 12 of the envelope, i.e., over or proximal to the adhesive sealant AS or glue line of the flap 12. Once again, when the sealing module 36 closes the flap 12 onto the body portion 14, the moistening liquid/activating agent combines and activates the material 10.

Once the mailpiece envelope 16 is filled and sealed, the envelope 16 travels to the inspection module 40 where an inspection of the sealing interface SI is performed. The visual inspection module 40 includes a non-contact sensing device 42 which is operative to provide a condition signal indicative of a characteristic property pattern 44 (shown graphically in FIG. 2) exhibited by the material 10 along the sealing interface SI. In the context used herein, a “non-contact sensing device” is any detection device which does not require that the sealing interface be touched, probed, separated or lifted to provide evidence that a seal has been formed. Furthermore, a “characteristic property pattern” means the electrical (i.e., digital or analog) representation of the sensed characteristic property along the sealing interface SI. For example, if the sealing interface SI has changed from the color blue to the color pink along the entire length of the sealing interface SI, then the sensing device 42 issues a condition signal indicating that reflected light is within a particular band of wavelength, e.g., the color pink, and spans a particular portion of the sealing interface SI. Devices useful for detecting color include scanning devices capable for distinguishing between multiple wavelengths/bands of light. These include narrow-band wavelength detectors such as TSL257 series from TAOS Inc, Plano Tex., multiple band wavelength detectors such as TCS230, TCS3404, or TCS3414 also from TAOS Inc., Plano Tex., spectrophotometers such as TeleFlash130, Teleflash 445, VeriColor Solo and Vericolor Spectro from X-Rite Inc., Grand Rapids, Mich.

A processor 46 develops the sensed characteristic property pattern CP from the condition signal and compares it to a known acceptance standard pattern SP which has been created and stored in a memory device (not shown). The acceptance standard pattern SP provides a baseline for an acceptable seal and may include some margin for variance/deviation beyond the baseline. If the characteristic property pattern CP is equivalent to, or within the margins of, the acceptance standard pattern SP, then the seal integrity is deemed acceptable and processing continues, i.e., the mailpiece is weighed and franked, until the mailpiece is complete. If, however, the characteristic property pattern CP and acceptance standard patterns SP are disparate/incongruous, then the mailpiece envelope 16 may be out-sorted due to a seal deficiency.

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Various experiments and tests were performed to demonstrate practical applications of the inventive method. A description of each will provide an understanding of the various approaches/methods which can be used to provide the requisite seal integrity evidence. Each will be described in terms of the characteristic property exhibited and inspected.

Characteristic Property—Color Change—Dyes/Dye Developers

In a first experiment, dyes/dye developers were employed along the sealing interface SI to provide evidence of seal integrity. In FIGS. 3a and 3b, a leuco dye 10LD was incorporated along the sealing interface SI or, more precisely, along the flap 12 of the envelope 16. Furthermore, a dye developer 10DD was incorporated along the opposing side of the sealing interface SI, or along the body portion 14 of the envelope 16. Additionally, the envelope 16 was modified to include a plurality of openings 12O covered by a translucent or transparent window 12W. These windows 12W are similar to a conventional transparent envelope windows employed for viewing a destination or return address printed on the internal content material of a mailpiece. The openings 12O were relatively small, i.e., smaller than the width of the adhesive sealant AS, and may be circular or oval in shape, thus allowing the sealant AS to circumscribe/surround the openings 12O.

In the test performed, a first material i.e., the leuco dye 10LD, was applied to a transparent plastic material which was subsequently bonded over apertures disposed through an existing sealant strip of a conventional mailpiece envelope. The dye-coated plastic material, therefore, produced windows 12W in and about the sealant strip AS. A second material, or the dye developer 10DD was also applied to the body 14 of the envelope 16. The leuco dye 10LD and dye developer 10DD were initially clear or colorless.

The flap 12 of the envelope 16 was exposed to an aqueous solution of EZ-seal moistening liquid and closed onto the body portion 14 of the envelope 16. In the presence of the moistening liquid, both the leuco dye 10LD and dye developer 10DD began to flow and combined. Furthermore, the leuco dye 10LD and dye developer 10DD combined to produce a dark violet color. While the color change may be viewable by a variety of methods, e.g., backlighting the envelope to view a change in contrast through the envelope, the color change exhibited by the combined dye and dye developer 10LD, 10DD were clearly viewable through the transparent window 12W.

Leuco dye classes which may be used include: fluorans, spiropyran, quinones, thiazines, oxazines, phenazines, phthaldes, triarylamin, tetrazolium salts, etc. In the described embodiment, the leuco dye material was a crystal violet lactone and the dye developer was a Bisphenol A. While these materials, when combined, exhibit a characteristic property of the color “purple”, other dyes and dye developers may be used to produce viewable color changes. Table I below provides a list of dyes and dye developers which may be used to produce characteristic properties which may be sensed by a non-contact sensing device, i.e., a conventional color scanning apparatus. The dyes may be used with any of the dye developers and the selection of one or another depends on a variety of factors including cost, availability, reaction time, etc.

TABLE I

| DYE   | DYE DEVELOPER          |
|---|------------------------|
| 2'-anilino-6'-diethylamino-3'-methylfluoran             | Benzyl Paraben         |
| 3,3-bis(p-dimethylaminophenyl)-6-dimethylaminophthalide | p-hydroxy benzoic acid |
| 3,3-bis(4-dimethylaminophenyl)-phthalide                | Benzyl ester           |
| Malachite Green Lactone                                 | Zinc salicylate        |

#### Characteristic Property—Color Change—Water Sensitive Materials

In another experiment and referring to FIGS. 4a, 4b and 4c, a water sensitive material, e.g., a moisture indicator, was deposited at discrete locations L1, L2, L3, and L4 along the body portion 14 of an envelope 16. In this embodiment, the water sensitive material changes color, e.g., from a blue color to a pink color, in the presence of water or any aqueous solution. While the previous embodiment of the invention, relating to the use of a dye and dye developer, employed a translucent/transparent window to facilitate viewing by a color scanning device 46 (FIG. 2), in this embodiment, at least a portion LP of the material 10WS is deposited below the edge 12E of the flap 12 such that the color change can be viewed directly (a feature which will be discussed in the subsequent paragraph).

According to the experiment performed, circular deposits 10WS of cobalt chloride were equally spaced along and arranged to follow the V-shaped edge contour of the flap 12. Furthermore, a first portion LP of the cobalt chloride was deposited to extend below the flap edge 12E. A color change, i.e., from blue to pink, was effected by moistening the adhesive sealant AS along the flap 12 and closing the flap 12 onto the body 14 of the envelope 16 such that the moistening fluid MF (see FIGS. 4b and 4c) contacted a second portion UP of each circular deposit 10WS, i.e., the portion UP disposed under the flap 12. Inasmuch as the cobalt chloride is highly absorptive, the moistening fluid wicked into the material 10WS and into the first portion LP of each circular deposit 10WS. As a result, the color change, i.e., from blue to pink, was viewable and could be sensed by conventional color scanning apparatus.

While a ten percent (10%) solution of cobalt chloride was used in the experiments performed, it may be desirable to include stabilizing agents to the material 10WS to increase its shelf-life and prevent premature activation. That is, to prevent moisture from the ambient environment from activating the material 10WS, it may be desirable to admix the material with a solution of polyvinyl alcohol. A solution of about seventy percent (70%) cobalt chloride and thirty percent (30%) polyvinyl alcohol should prevent premature activation.

Table II below provides a list of moisture indicators which may be used to produce the characteristic properties which may be sensed by a conventional color scanning apparatus.

TABLE II

| Indicator                   | Color               |
|-----------------------------|---------------------|
| Copper(II) Chloride         | Brown to Light Blue |
| Porphyrim/MgCl <sub>2</sub> | Green to Purple     |

#### Characteristic Property—Color Change—Variable pH

In another embodiment of the invention, the pH values of the envelope and the adhesive sealant may be selectively combined to produce a visible change in color at the sealing interface. In this embodiment, an envelop having a first pH

value is selected, i.e., the pH value of the matrix which binds the fibrous material of the envelope, for combination with an adhesive sealant having a second pH value. By selecting combining these values such that they differ by some a threshold value a visible change in color can be detected. The difference in pH is greater than about 0.5, and preferably greater than about 0.7.

More specifically, when a moistening fluid is introduced onto the flap of the envelope and the flap is closed against the body portion of the envelope, the material or binding matrix within the envelope, i.e., having one pH value, is brought into contact the adhesive sealant, i.e., having another pH value. As a result of the difference in pH values i.e., between the adhesive sealant and the envelope produces a visible change in color at the sealing interface.

Table III is a list of acid base indicators are suitable for the detection of envelope sealing:

TABLE III

| Name               | Acid Color        | Base Color        |
|--------------------|-------------------|-------------------|
| Azolitman          | Red (pH < 5.0)    | Blue (pH > 7.5)   |
| Bromocresol Purple | Yellow (pH < 5.2) | Purple (pH > 6.8) |
| Brilliant Yellow   | Yellow (pH < 6.5) | Orange (pH > 7.5) |
| Bromothymol Blue   | Yellow (pH < 6.0) | Blue (pH > 7.5)   |
| Phenol Red         | Yellow (pH < 6.5) | Red (pH > 7.2)    |
| Metacresol Purple  | Yellow (pH < 7.0) | Purple (pH > 7.8) |

#### Characteristic Property—Temperature Change

In yet another embodiment of the invention, seal integrity may be confirmed by inspecting the thermal effects at the sealing interface SI. In this embodiment, any combination of materials 10TR which produces a thermal reaction may be used. For example, a material 10TR which reacts thermally in the presence of an aqueous solution may be employed. Alternatively, a material 10TR which reacts thermally in the presence of another material may also be used.

In this embodiment, a first material 10TR which is thermally reactive to an aqueous solution, is deposited at various known locations along the sealing interface SI. For example, a material 10TR containing a small concentration of sulfur or magnesium may be disposed on the body portion 14 of the envelope 16 in a location corresponding to the sealing interface SI. In the presence of water and, in particular, in the presence of the oxygen molecules therein, the material 10TR releases heat in an exothermic reaction. This heat energy, which manifests itself as a small rise in temperature, is the characteristic property exhibited by the material and may be detected by a conventional IR detector, i.e., the non-contact sensing device 46 shown in FIG. 2. Furthermore, inasmuch as a conventional paper-based envelope is essentially invisible to long-wavelength energy (i.e., in the IR spectrum), the flap 12, which is disposed over the sealing interface SI, does not block or inhibit the detection of the released energy. Should the difference in temperature exceed a threshold value, it can be assumed that the sealing interface has been moistened along the length of the sealing strip or, minimally at critical locations along the length (discussed in the subsequent paragraph) and that the efficacy of the adhesive seal is within acceptable margins.

To ensure that heat energy sensed is transmitted by the sealing interface SI and not as a result of variations in ambient conditions surrounding the envelope (e.g., heat generated by the mailpiece creation system 30), the material 10TR may be deposited at discrete locations along the interface SI. As a result, a comparison may be made between the heat released/

temperature at each location and the heat released/temperature at locations between the deposited material 10TR.

Table IV is a list of various materials 10TR which may be used to produce a measurable change in the thermal signature produced along the sealing interface SI.

TABLE IV

| Reactive Material      | Activating Agent  |
|------------------------|-------------------|
| Calcium Oxide          | Water             |
| Calcium Chloride       | Water             |
| Potassium Permanganate | Glycerine         |
| Fe/NaCl                | Hydrogen Peroxide |

Although the invention has been described with respect to a preferred embodiment thereof, it will be understood by those skilled in the art that the foregoing and various other changes, omissions and deviations in the form and detail thereof may be made without departing from the scope of this invention.

The invention claimed is:

**1.** A method for producing an envelope having improved seal integrity, the envelope having a flap and a body portion between which an adhesive seal is formed, the method comprising the steps of:

disposing a one material on one of the flap and the body portion of the envelope, the material radiating thermal energy when combined with an activating agent;

disposing the activating agent on the other of the flap and body portion of the envelope;

sealing the envelope by closing the flap onto the body portion of the envelope to form a sealing interface, thereby combining the material with the activating agent at the sealing interface so as to effect a change in the thermal energy radiated therefrom; and

inspecting the sealing interface to determine whether the thermal energy radiated from the activated material has changed thereby confirming that a seal has been produced between the flap and body portion of the envelope.

**2.** The method according to claim 1 wherein disposing a material on one of the flap and body portion includes depositing the material on the body portion of the envelope, and wherein sealing the envelope includes wetting the flap of the envelope with an aqueous solution such that closing the flap onto the body portion combines the material with the aqueous solution to change the thermal energy radiated from the material.

**3.** The method according to claim 2 wherein depositing the material on the body portion of the envelope includes depositing the material at discrete locations along the sealing interface and wherein inspecting the sealing interface includes comparing the thermal energy radiated by the material to the thermal energy radiated from areas located between the deposits of material.

**4.** The method according to claim 2 wherein disposing a material on one of the flap and body portion of the envelope includes depositing a solution of calcium chloride on the body of the envelope.

**5.** The method according to claim 2 wherein disposing a material on one of the flap and body portion of the envelope includes depositing a solution of calcium oxide on the body of the envelope.

**6.** The method according to claim 1 wherein combining the material with the activating agent produces an exothermic reaction.

**7.** The method according to claim 1 wherein combining the material with the activating agent produces an endothermic reaction.

**8.** The method according to claim 1 wherein inspecting the sealing interface includes examining the sealing interface with an InfraRed (IR) sensing device.

**9.** The method according to claim 1 wherein the activating agent is a solution containing glycerine and disposing a material on one of the flap and body portion of the envelope includes depositing a solution of potassium permanganate on the body of the envelope.

**10.** The method according to claim 1 wherein the activating agent is a solution containing hydrogen peroxide and disposing a material on one of the flap and body portion of the envelope includes depositing a solution of Fe/NaCl on the body of the envelope.

**11.** A system for producing a mailpiece having improved seal integrity, the mailpiece including an envelope having a body portion for accepting mailpiece content material and a flap integrated with the body portion to enclose the mailpiece content material within the body portion, the flap adapted to fold onto the body portion to define a sealing interface therebetween, the body portion of the envelope including a material deposited at discrete locations along the sealing interface, the material producing a thermal reaction that radiates thermal energy when exposed to an activating agent, the system comprising:

a conveyor system for transporting the envelop along a feed path;

at least one inserter module for inserting content material into the body portion of the envelope as the envelope is conveyed along the feed path;

a sealing module disposed downstream of the inserter module and accepting the envelope along the feed path, the sealing module operative to apply an activating agent to the flap along the sealing interface and to fold the flap onto the body portion of the envelope so as expose the material to the activating agent and produce a sealed envelope;

a visual inspection module disposed downstream of the sealing module and accepting the sealed envelope, the inspection module including a non-contact sensing device operative to provide a condition signal indicative of a thermal energy radiated along the sealing interface; and

a processor, responsive to the condition signal, for comparing the thermal energy radiated by the activated material to the thermal energy radiated by regions between the activated material, and for determining whether the difference in thermal energy is greater than a threshold level and whether an acceptable seal has been formed between the flap and body portion of the envelope.

**12.** The system according to claim 11 wherein the non-contact sensing device is an InfraRed (IR) sensor.

**13.** The system according to claim 11 wherein the at least one material is selected from the group of: calcium oxide, calcium chloride, potassium permanganate and Fe/NaCl.